NASA Goddard Space Flight Center Ocean Data Processing System Operations, Project Data and Software Management Plan

August 2012

1.0 INTRODUCTION

This document describes the Operations and Project Data Management Plan (PDMP) for the Ocean Data Processing System (ODPS) at the NASA Goddard Space Flight Center (GSFC). The ODPS performs scientific data acquisition, processing, archiving and distribution for several past and current ocean remote sensing satellite sensors, and will also be supporting future sensors as well. Each supported mission and sensor is summarized in Section 2 below.

1.1 Purpose and Scope

This data management plan describes the acquisition, generation, management and distribution of science data products generated by the ODPS. Covered in this plan are:

- Brief description of the programs and sensors
- Generic operations concept and mission-unique features and responsibilities.
- Description of the data flows
- Description of the science data products
- Data availability and distribution policies

1.2 PDMP Development, Maintenance, and Management Responsibility

The Ocean Biology Processing Group (OBPG) within the GSFC Ocean Ecology Laboratory, Code 616, is responsible for the development, maintenance, and management of the ODPS PDMP. The ODPS Manager, Dr. Gene C. Feldman, has overall responsibility for the plan, and will have specific responsibility for approving any changes to the plan.

2.0 MISSION AND SENSOR OVERVIEW

The ODPS supports the following past, present and future missions and sensors, listed in chronological order by launch date.

- Nimbus-7 Coastal Zone Color Scanner (CZCS)
- Advanced Earth Observing Satellite (ADEOS) Ocean Color and Temperature Scanner (OCTS)
- OrbView-2 (OV-2) Sea-viewing Wide Field-of-view Sensor (SeaWiFS)
- Terra Moderate Resolution Imaging Spectroradiometer (MODIS) and Aqua MODIS
- Envisat Medium Resolution Imaging Spectrometer (MERIS)
- Satelite de Aplicaciones Científicas D (SAC-D) Aquarius
- National Polar-orbiting Partnership (NPP) Visible and Infrared Imager Radiometer Suite (VIIRS)

Each mission and sensor is summarized in the following sections.

2.1 Nimbus-7 CZCS

The Nimbus-7 satellite was the last in a series of Earth remote sensing mission launched by NASA in the 1960's and 1970's. The mission is summarized in Table 1.

Table 2-1 – Nimbus-7 Mission Summary

Launch Date	October 25, 1978
Orbit Type	Polar Sun-synchronous
Altitude (nominal)	955 km
Equator crossing time/direction	12 noon ascending
Orbit Period	~104 minutes

CZCS was the first satellite-based ocean color sensor, and was flown on Nimbus-7 as a proof-of-concept experiment. The onboard data storage was limited, and data collection was scheduled over designated locations. Data collection spanned nearly eight years, from October 30, 1978 to June 22, 1986. The instrument was officially declared dead on December 18, 1986.

Table 2-2 – CZCS Summary

Instrument Type	Cross-track scanning spectrometer
Resolution	825 m
Bands/channels	6 bands, 443 nm to 11.5 microns
Swath width	1556 km
Sensor Output	8 bit, single gain
Tilt	-20 to +20 degrees

2.2 ADEOS OCTS

ADEOS was launched and operated by the Japanese space agency (then NASDA, now JAXA). It was designed for a multi-year mission but suffered a fatal spacecraft control failure after nine months of operations.

Table 2-3 – ADEOS Mission Summary

Launch Date	August 17, 1996
Orbit Type	Polar Sun-synchronous
Altitude (nominal)	800 km
Equator crossing time/direction	10:30 AM descending
Orbit Period	101 minutes

OCTS included bands for both ocean color (visible/NIR) and thermal IR measurements. It collected global ocean data from November 1, 1996 to the spacecraft failure on. June 30, 1997.

Table 2-4 – OCTS Summary

Instrument Type	Cross-track scanning radiometer
Resolution	700 m
Bands/channels	12 bands, 412 nm to 12.5 microns
Swath width	1400 km
Sensor Output	10 bit, single gain
Tilt	0, +/- 20 degrees

2.3 OV-2 SeaWiFS

OrbView-2 was launched and initially operated by Orbital Sciences Corporation (OSC). The ownership and operations were transferred to ORBIMAGE, a subsidiary of OSC, in 1998, and ORBIMAGE became GeoEye in 2006. OV-2 stopped responding to commands on December 11, 2010, and was declared dead by GeoEye.

Table 2-5 – OV-2 Mission Summary

Launch Date	August 1, 1997
Orbit Type	Polar Sun-synchronous
Altitude (nominal)	705 km (at launch)*
Equator crossing time/direction	12 noon descending (at launch)*
Orbit Period	~99 minutes

*The orbit was not maintained. The altitude decayed to ~690 km and the crossing time drifted to ~02:22 PM. In July 2010 the orbit was raised to 781.5 km to reverse the crossing time drift. By the end of the mission the crossing time had drifted back to ~02:08 PM.

SeaWiFS was the first sensor designed to support global ocean color data collection, although it was preceded into orbit by OCTS. Routine data collection was started on September 18, 1997. Global Area Coverage (GAC) data, which are recorded globally, are subsampled at 4x4 from the full-resolution sensor data, and also truncated at the start and end of the scan. Local Area Coverage (LAC) data are collected at full resolution, and recorded in limited quantities over selected targets; full-resolution are also direct-broadcast to ground stations in High Resolution Picture Transmission (HRPT) format. The sensor continued to operate normally with no apparent problem until the end of the mission.

Table 2-6 – SeaWiFS Summary

Instrument Type	Cross-track scanning radiometer
Resolution	1.1 km
Bands/channels	8 bands, 412 to 865 nm
Swath width	1500 km (GAC), 2800 km (LAC)
Sensor Output	10 bit, bilinear gain
Tilt	0, +/- 20 degrees

2.4 Terra and Aqua MODIS

Terra and Aqua were the first two (of three, the third being Aura) large Earth Observing System (EOS) satellites launched and operated by NASA. Both EOS missions are multi-sensor and multi-disciplinary, and continue to operate without significant problems.

Table 2-7 – Terra Mission Summary

Launch Date	December 18, 1999
Orbit Type	Polar Sun-synchronous
Altitude (nominal)	700 km
Equator crossing time/direction	10:30 AM descending
Orbit Period	98.9 minutes*

Table 2-8 – Aqua Mission Summary

Launch Date	May 4, 2002
Orbit Type	Polar Sun-synchronous
Altitude (nominal)	700 km
Equator crossing time/direction	1:30 PM ascending
Orbit Period	98.9 minutes*

* Maintains 16-day repeat cycle

The MODIS instruments flown on Terra and Aqua were of identical designs. Terra MODIS was designated the proto-flight model (PFM) and started data collection on February 24, 2000; Aqua MODIS was designed Flight Unit 1 and started data collection on July 3, 2002. MODIS supports multidisciplinary (ocean, land and atmosphere) data product generation. Both instruments continue to operate nominally.

Table 2-9 – MODIS Summary

Instrument Type	Cross-track scanning radiometer
Resolution	1 km, 500 m and 250 m
Bands/channels	36 bands, 412 nm to 14 micron
Swath width	2300 km
Sensor Output	12 bit, single gain
Tilt	None

2.5 Envisat MERIS

Envisat was developed and launched by the European Space Agency (ESA). The payload consisted of 10 science instruments, including MERIS. Envisat stopped responding to commands on April 8, 2012, and was subsequently declared dead by ESA.

Table 2-10 – Envisat Mission Summary

Launch Date	March, 2002
Orbit Type	Polar Sun-synchronous
Altitude (nominal)	800 km
Equator crossing time/direction	10:00 AM descending
Orbit Period	101 minutes

The MERIS instrument is a programmable, medium-spectral resolution, imaging spectrometer operating in the solar reflective spectral range. Fifteen spectral bands can be selected by ground command, although the selected band suite remained fixed for the duration of the mission. The instrument scans the Earth's surface by the "push-broom" method. Linear charge-coupled device (CCD) arrays provide spatial sampling in the across-track direction, while the satellite's motion provides scanning in the along-track direction. MERIS data collection started on May 1, 2002. The instrument generates data at both full 300-meter resolution (FRS) and 1.2-km reduced resolution (RR) format. The FRS is only downlinked through direct broadcast or limited regional acquisitions, while the RR data is recorded and downlinked over the full daylit portion of every orbit.

Table 2-11 – MERIS Summary

Instrument Type	Multi-camera pushbroom radiometer
Resolution	300 m (FRS) and 1.2 km (RR)
Bands/channels	15 programmable bands, 390 to 1040 nm
Swath width	1150 km
Sensor Output	bit, single gain
Tilt	None

2.6 SAC-D Aquarius

SAC-D is the fourth scientific satellite built by Comision Nacional de Actividades Espaciales (CONAE) in Argentina. CONAE is headquartered in Buenos Aires, and the Mission Operations Center is located in Cordoba. SAC-D was be launched by NASA, and is operated by CONAE. The payload also includes seven science instruments developed by CONAE and other agencies.

Table 2-12 – SAC-D Mission Summary

Launch Date	June 10, 2011
Orbit Type	Polar Sun-synchronous
Altitude (nominal)	657 km
Equator crossing time/direction	6:00 PM ascending
Orbit Period	98 minutes*

* Maintains 7-day repeat cycle

The Aquarius instrument is the first satellite-based ocean salinity sensor. It was built by NASA flown on SAC-D. Aquarius combines a passive radiometer with an active pulsed radar scatterometer, which share the same optics (feed horns and antenna). The radiometer was built at GSFC, and the scatterometer and overall integration were the responsibility of the NASA Jet Propulsion Laboratory (JPL).

Table 2-13 – Aquarius Radiometer Summary

Instrument Type	Passive microwave polarimeter
Resolution	~100 km
Bands/channels	1.413 GHz, three feed horns with four polarization states each
Swath width	~400 km
Sensor Output	16 bit
View	Boresights 25.8 to 40.3 degrees off nadir (fixed), ~6.5 degree beam size

Table 2-14 – Aquarius Scatterometer Summary

Instrument Type	Active radar scatterometer
Resolution	~100 km
Bands/channels	1.26 GHz, three feed horns with four polarization states each
Swath width	~400 km
Sensor Output	16 bit
View	Boresights 25.8 to 40.3 degrees off nadir (fixed), ~6.5 degree beam size

2.7 NPP VIIRS

The NPP satellite was built and launched by NASA as a risk reduction mission for the Joint Polar Satellite System (JPSS). Oversight for JPSS is shared by the National Oceanic and Atmospheric Administration (NOAA) and NASA. NPP carries four other sensors besides VIIRS. Following launch, spacecraft and instrument commissioning, the mission operations were handed off from NOAA to NASA.

Table 2-15 – NPP Mission Summary

Launch Date (planned)	October 28, 2011
Orbit Type	Polar Sun-synchronous
Altitude (nominal)	830 km
Equator crossing time/direction	1:30 PM ascending
Orbit Period	101.6 minutes*

* Maintains 16-day repeat cycle

VIIRS will be flown on every JPSS satellite as well as on NPP. It is conceptually similar to MODIS, with comparable resolution, spectral coverage and support for multidisciplinary data product generation.

Table 2-16 – VIIRS Summary

Instrument Type	Cross-track scanning radiometer
Resolution	750 m and 375 m
Bands/channels	22 bands, 412 nm to 12 micron
Swath width	3040 km
Sensor output	12 bit, dual/single gain
Tilt	None

3.0 ODPS DATA PROCESSING

3.1 Project-wide Processing

This section describes the ODPS activities that are common to all missions and sensors. An overview of the Data Processing is provided, followed by descriptions of Data Archive and Management, Data Distribution, and Software Configuration Management.

3.1.1 Data Processing Overview

The data processing for all sensor data within the ODPS is similar in nature. All data processing and management is controlled by non-mission-specific process scheduling and data management components. These comprise a fully automated, distributed data system for acquiring, processing, archiving, and distributing scientific data. The system is highly scalable and easily adaptable to support multiple concurrent missions. The following subsections describe the ODPS scheduling and archiving system and the science data processing software.

Scheduling and Archiving System

The components of the ODPS are: the Scheduler/Visual Database Cookbook (VDC), the Archive Device Manager (ADM), Data Acquisition and Ingest, File Migration and Management, and Data Distribution. The last two will be described in other sections.

- The Scheduler/VDC runs in a daemon-like state and monitors task records in the to-do list table. It runs tasks according to defined task attributes. A standard job-shell interface allows new programs to be quickly adapted for Scheduler control.VDC uses recipes to encapsulate data-specific processing schemes and parameters. It defines Virtual Processing Units (VPUs) as distinct distributed processing resources. VPUs are dynamically allocated based on available time and the current OS load. VDC also supports prioritization of processes and resources.

- ADM supports logical pools of storage devices. When processes request a device in a specific pool, ADM returns information for a storage device in the requested pool. A disk-monitor process polls all devices periodically to record usage statistics and invoke threshold handlers.

- Data acquisition and ingest is performed using active, passive, and periodic notification methods. The active method scans remote systems for new files and populates the ingest queue. The passive method waits for arrival of E-mail messages describing type and location of new file and populates the ingest queue. The periodic method schedules ingests of files at user-specified intervals.

Scientific Data Processing Software

The data from the various sensors are processed to standard levels as defined by EOS. The products and levels are described more fully in Section 4. The processing steps for all sensors

include: Level-0 to 1A (unpacking), Level-1A to 1B (calibration), Level-1B to 2 (geophysical parameter retrieval), and Level-2 to 3 (spatial and temporal compositing). At each level, the products are stored and cataloged for subsequent retrieval or distribution.

The initial processing steps, unpacking and calibration, are sensor-specific, and are determined by the raw (Level 0) data format and the calibration approach for each sensor. The retrieval and compositing steps for most sensors and products, i.e., Ocean Color and Sea Surface Temperature (SST), are performed using multi-sensor software:

- The Multi-sensor Level-1 to Level-2 (l2gen) software performs the geophysical parameter retrieval. This includes atmospheric correction, determination of surface parameters (either remote sensing reflectance (Rrs) or brightness temperature), and determination of geophysical values (chlorophyll and optical properties for Ocean Color, or temperature for SST). For CZCS and SeaWiFS, the inputs to l2gen are the Level-1A (uncalibrated) data, so the processing for these sensors requires the calibrations and sensor corrections to be applied by l2gen before the other steps.

- The temporal and spatial compositing are performed by the l2bin and l3bin programs. The l2bin software accumulates the geophysical values for a single day into equal-area bins, either 9.2 or 4.6 km in size, and l3bin composites data from multiple days (see Level 3 product descriptions below).

- The smigen program re-projects the composited binned data into standard mapped images based on an equi-rectangular (Plate Carré) grid.

The Level-2 processing also requires dynamic ancillary data from a number of sources. The data are common across sensors, but are product-specific. A summary of ODPS ancillary data types and sources is given in Table 3-1.

Table 3-1. Ancillary Data Types and Sources

Data Type	**Static/ Dynamic**	**Primary Source**	**Backup Source(s)**
Ozone	D	OMI	TOMS Climatology (seasonal)
Meteorological	D	NCEP	Climatology (seasonal)
SST	D	Reynolds OISST	Climatology (seasonal)
NO_2	D	OMI	Climatology (seasonal)
Sea Ice	D	NSIDC	Climatology (seasonal)
Land Mask	S	World Vector Shoreline (SeaWiFS)	None
Elevation	S	Digital Elevation Map	None

The Aquarius salinity data processing, which will be unique within the ODPS, will not utilize the general-purpose code. This processing will require unique, algorithm-specific software to perform the retrieval and compositing steps, as described below. In addition, the generation of VIIRS data products involves use of NOAA processing code as well as the standard ODPS multi-sensor software.

Data Processing Streams

The processing for each sensor is performed multiple times. There are separate processing streams for the forward-stream (newly received data) processing and reprocessing. In addition, the forward stream is processed twice, initially for Performance Assessment and subsequently for Refined product generation. Each processing stream is described below.

The *Performance Assessment* processing is performed for all operational sensors as soon as the data are acquired by the ODPS. The main purpose of this processing is to detect any instrument anomalies as soon as possible. In most cases the highest quality ancillary data will not be available for this stream, so the processing will be performed with the best available data, which may be climatology.

The *Refined* processing is performed when the highest quality ancillary data are available, typically within three or four weeks of the sensor data acquisition. The Refined products will replace the previously-generated Performance Assessment version in the archive, and will be distributed until such time as reprocessing is performed.

Full-mission *Reprocessing* is performed periodically to incorporate improved sensor calibrations, algorithm improvements and updates to ancillary data (e.g. NCEP reanalysis products). The typical interval between reprocessings can range from several months in the early stages of missions, when calibration and algorithm updates are frequent, to several years for sensors that are well-characterized with stable algorithms. During each reprocessing, the new data products replace the previous version in the archive. It is also standard ODPS practice to synchronize the software and calibration between the reprocessing and forward streams at the inception of reprocessing, to ensure consistency among the products.

3.1.2 Data Archiving, Management and Integrity

During data acquisition and processing, file migration and management involves compressing files and migrating them to their various destinations. Event- or time-based triggering queries associated with each trigger are run periodically by a Scheduler task to select files that are eligible for some type of migratory action and populate a migration queue. Command-line queuing is used for file removal and delayed copies. Migration daemons query the migration queue, perform specified actions on the files, and update the catalog tables

The ODPS maintains online storage for the current archived versions of all data products from all sensors. In addition, data stores are maintained for evaluation and test products.

Data integrity is maintained through a combination of internal consistency checks and data backups. All data files are compressed using the “bzip2” or “gzip” compression utilities. Each utility allows testing of file integrity as needed. Data backups of Level 1 science products are created as the product is generated on the system. Once the product has been copied to the primary storage area, a second copy of the file is created on a separate storage device. The location of each file is retained in the on-line data catalog for easy retrieval. Science products

above Level 1 do not receive a second copy as they can be quickly recreated from the Level 1 data. Cooperative agreements with other projects provide alternate sources for copies of low-level (Level-0 or 1A) data. Higher-level products are recreated from those files if necessary.

3.1.3 Data Distribution

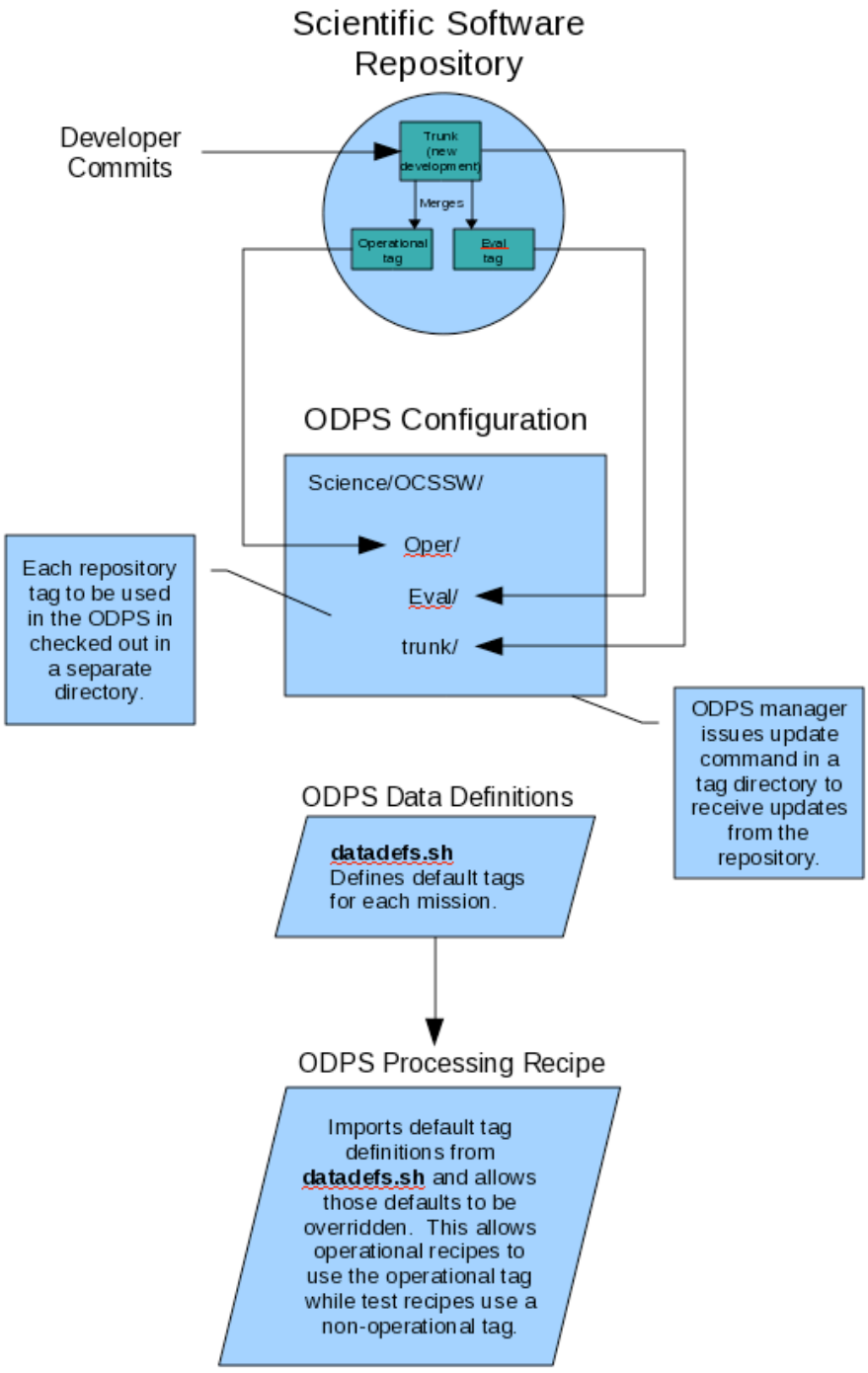
Several methods of distribution are used by the OCDPS. Individual files can be downloaded from the project website (http://oceancolor.gsfc.nasa.gov). An order processing system is available on the web site, allowing users to place orders for batches of files. The files are collected from the network attached storage (NAS) and staged onto one or more of the distribution FTP servers for later retrieval by the user. Users can also establish a data subscription, where data is automatically staged to the distribution ftp servers and the user is notified when the data is available. Certified source code is also posted to the distribution servers, allowing the science community access to the code used to generate the products. An on-line forum (http://oceancolor.gsfc.nasa.gov/forum/oceancolor/forum_show.pl) is available to allow members of the science community to interact easily with the OBPG and each other.

The interactive, web-based Data Ordering System is currently supporting SeaWiFS, Aqua MODIS, Terra MODIS, OCTS, CZCS, MERIS, Aquarius and VIIRS. The Data Subscription System allows users to define region and products of interest. The Order and Subscription Manager monitors the order and subscription queues and stages files on FTP servers (stage rate ~12 GB / hr). Web-CGI applications allow users to view and update their orders and subscriptions.

It has been standard ODPS policy to publicly release all versions of all data products as soon as they are processed, except for sensors which have specific restrictions (e.g. commercial data rights). Products that are still undergoing validation are indicated as provisional. Exceptions to this policy are noted for each sensor in the following sections.

3.1.4 Software Configuration Management

All software development and deliveries to the ODPS are controlled through a Subversion-based configuration management system. The repository is organized into build, run, and test directories, where build includes subfolders of source code and makefiles for each distinct processing program or support library, run includes all static data tables and compiled executable programs, and test includes a standard set of test files and scripts to verify the performance of each program after a change is made. The software developer maintains a working copy of the repository on his or her workstation, and develops, compiles, and tests the code within this working copy. Periodic updates of the working copy are performed to capture changes from other developers. When satisfied that a software change is performing to expectations, the source code, compiled executables, and test results are committed to the repository. All changes are automatically tracked by Subversion, and the repository configuration can always be reverted to a previous state if need be.


Scientific Software Repository
Developer Commits
Trunk (new development)
Merges
Operational tag
Eval tag
ODPS Configuration
Science/OCSSW/
Oper/
Eval/
trunk/
Each repository tag to be used in the ODPS in checked out in a separate directory.
ODPS manager issues update command in a tag directory to receive updates from the repository.
ODPS Data Definitions
datadefs.sh
Defines default tags for each mission.
ODPS Processing Recipe
Imports default tag definitions from datadefs.sh and allows those defaults to be overridden. This allows operational recipes to use the operational tag while test recipes use a non-operational tag.

Each processing server within the production processing system also contains a working copy of the "run" path within the software repository. When the time comes to deliver a software update to the production processing system, the lead software developer "tags" the fully tested software repository with a new version number, effectively defining a temporal snapshot of the repository. The lead processing system manager then issues a Subversion command on each server to "switch" the current production tag to the new tag. For testing purposes, the data processing has the ability to maintain multiple tagged software versions on the production servers, and to specify which tag to use for a particular test or reprocessing event.

The science processing software is also distributed to the research community through the SeaWiFS Data Analysis System (SeaDAS) software package. The SeaDAS distribution is simply a working copy of the run and build paths for the current production tag of the software repository. This same approach can be employed to distribute the latest development versions of the software repository to external team members, where each member creates a local working copy of the repository that can be maintained through periodic update commands to the Subversion server.

3.1.5 Separating Operational and Evaluation Products

The ODPS uses the concept of product suites to distinguish one family of products from another. A product suite is defined in the ODPS database and has associated with it a unique numeric ID, name, and file label among other attributes. The processing recipes, the elements that define a set of processing steps for a processing scheme, are associated with a product suite. The processing scripts used by the recipe apply the attributes of the product suite associated with the recipe to derive the names of the output products. This allows the ODPS to generate unique file names for each product suite. As products are recorded in the ODPS database, the numeric suite ID is stored along with the other product metadata so the products for a particular suite can easily be identified using a basic database query.

For each mission the ODPS supports, there are typically defined a set of operational recipes and a set of testing recipes. The operational recipes are configured to use the operational set of product suites and their configuration rarely changes. The set of testing recipes and product suites are usually more dynamic to accommodate multiple testing configurations, each one requires a unique set of file names. It is during the set up of a processing test that the ODPS manager configures the recipe to use a specific tag of the scientific software repository and to be associated with a numeric suite ID.

3.2 Sensor-specific Data Flows

This section describes the data flows that are unique for each sensor. This includes all of the data acquisition scenarios, which are always sensor-specific. Some sensors also have additional processing steps that are unique, as described below.

3.2.1 CZCS

The CZCS data for the entire mission were originally produced and stored as Level-1A products, with separate products for each scene (approximately 1 minute per scene). The format was binary, with a fixed record structure.

The reprocessing of the CZCS data with improved algorithms was supported under the Research, Education and Applications Solutions Network (REASoN) Cooperative Agreement Notice (CAN). These files were acquired from the Goddard Earth Science Distributed Active Archive Center (GESDAAC). To facilitate portability and further processing, the CZCS Level-1A data were reformatted by the ODPS. Software was developed to perform the following:

- All files corresponding to a single orbit (daylit side only) were combined into a single product, with any overlaps removed.

- The Nimbus-7 orbit vectors were regenerated for each scan line and stored with the data; this information was not included in the original binary files.

- The products were written using an HDF format, with metadata and other conventions previously developed by the OBPG for other sensor products.

The reformatted products have been generated and archived by the ODPS, and can be input to l2gen for downstream processing to generate Ocean Color products. The CZCS products are now being distributed by the ODPS.

3.2.2 OCTS

The OCTS global data set was acquired from NASDA in 2001 to support the reprocessing of this data by the OBPG to generate Ocean Color products. The data were provided at Level-1A (unpacked), and were subsampled like SeaWiFS GAC data. They were formatted by NASDA using HDF following many of the conventions previously developed by the OBPG, so no further reformatting was necessary. The OCTS data can be input directly into l2gen for downstream processing.

The original reprocessing of OCTS global data was completed in December 2001, and the OCTS Ocean Color products were delivered to the GESDAAC and to NASDA for distribution. Starting in 2005, further algorithm and refinement was supported under the REASoN CAN. The new Ocean Color products developed under the CAN are being distributed by the ODPS.

3.2.3 SeaWiFS

The OV-2 spacecraft and the SeaWiFS sensor were owned and operated by GeoEye. The data were purchased by NASA under “data buy” contracts. The initial contract covered the period from the initial imaging through five years after initial commissioning (September 4, 1997 through December 19, 2002). Since then, a series of contract extensions were negotiated between NASA and GeoEye, up to the end of the mission.

The SeaWiFS data were collected and acquired by two overall scenarios: onboard data recording and direct broadcast. SeaWiFS also had unique restrictions on data distribution because of the terms of the data buy contract.

Onboard Recorded Data

The GAC data and a limited amount of LAC were recorded onboard OV02 and downlinked twice daily. The primary station was located at GSFC Building 28, with a backup downlink collected by the Wallops Flight Facility. The data were also acquired by GeoEye, and could be acquired from that source if the primary and secondary sources failed. The downlinks were transmitted near local noon and midnight as the satellite passed over the stations.

The raw downlink data were frame-formatted to produce a SeaWiFS Level-0 file. This file was processed to Level-1A using the sensor-specific l1agen_seawifs software, which included the following steps: separating the data into individual scenes (GAC orbits or LAC segments); unpacking and converting the sensor and selected spacecraft telemetry; performing navigation processing; computing metadata; and writing each scene to a file using HDF. In addition, sensor and spacecraft telemetry in the GAC data were written to a separate file for display and analysis.

The scheduled LAC recording included daily solar, gain and time-delay-integration (TDI) calibrations and monthly lunar calibrations. These data were processed using l1agen_seawifs as part of the normal processing, but were written to special products and saved for offline analysis.

Direct Broadcast

The second data collection method used data that were direct-broadcast by OV-2 in parallel with the GAC data recording, in an HRPT format. In order to collect SeaWiFS HRPT data, a station purchased either a commercial or research license from GeoEye. These data were encrypted, and were decrypted using software and keys provided by GeoEye under the terms of the license. The OBPG collected HRPT passes at the Building 28 station during daylight overpasses (two or three per day). These data, once decrypted and frame-formatted, were also in SeaWiFS Level 0 format, and were identical to recorded LAC data. The data from each overpass were processed using l1agen_seawifs to generate a Level-1A product.

In addition, a large number of stations worldwide provided HRPT products to the OBPG until December 24, 2004. These data were generally processed to SeaWiFS Level-1A format using the l1agen_seawifs software provided to the stations by the OBPG. These products were renavigated upon receipt by ODPS to ensure that the latest navigation updates were incorporated into all of the ODPS-archived products. The renavigation involved a two-step process, in which the received products were first “reversed” to Level-0 format, and then processed using l1agen_seawifs.

In 2002, the OBPG developed the capability to merge all of the full-resolution (LAC and HRPT) data from each orbit into a single product. During this processing, any overlaps in products from nearby stations were removed, with the best-quality data for each scan line retained. The

archived HRPT products have since been replaced by the merged LAC (MLAC) products for each orbit, which are distributed by the ODPS.

The downstream processing of the SeaWiFS data to generate Ocean Color products is performed using the multi-satellite processing software as described in 3.1.

Data Distribution

Under the terms of the data buy contract, GeoEye retained all commercial rights to the SeaWiFS data products for five years after data collection. The following restrictions on SeaWiFS data distribution were imposed after the initial commissioning phase of SeaWiFS was completed (December 18, 1997).

- The distribution of NASA SeaWiFS data products within five years of data collection is limited to research and educational users, who must submit a request to the OBPG to become an authorized user.

- All public uses of SeaWiFS data products (publications, media reports, etc.) must contain an acknowledgement of NASA and GeoEye.

3.2.4 MODIS

The ODPS started acquiring MODIS data in 2003. The MODIS data (from both Terra and Aqua) have been acquired via two means. Originally the data were acquired from NOAA in near-real-time, with the GESDAAC and the MODIS Adaptive Processing System (MODAPS) as backups. More recently, MODAPS has become the primary source of the MODIS data.

The Level-0 files are processed to generate Level-1A, geolocation and Level-1B (calibrated) products, using software provided by MODAPS. The geolocation processing also requires attitude and ephemeris data files that are acquired from the GESDAAC. All of the Level-1 products follow the standard MODIS formats, including HDF-EOS metadata.

The downstream processing of the MODIS data is performed using the OBPG multi-satellite processing software as described in 3.1. The daytime granules are processed to generate the Ocean Color products, and all of the granules are used to generate SST products.

3.2.5 MERIS

The MERIS FRS and RR data were acquired through a bulk-data-exchange agreement between NASA and ESA. Global RR Level-1B data were transferred via ftp from the ESA UK-PAC data distribution facility. FRS data were provided by ESA to the LAADS group at NASA on tapes. FRS files were extracted from tape by LAADS and transferred to OBPG for higher-level processing.

The downstream processing of the MERIS Level-1B data is performed using the OBPG multi-satellite processing software as described in 3.1. The data exchange agreement between NASA

and ESA included the rights to redistribute the ESA Level-1B data and derived products. These products are being made available through the OBPG browse search and order site.

3.2.6 Aquarius

The Aquarius data products and processing software are unique within the ODPS, since the microwave data processing and salinity retrieval algorithms are completely different from those for Ocean Color and SST. The ODPS systems that support Aquarius are referred to as the Ground Segment (GS), and the software and capabilities that are used to support Aquarius data processing are referred to as the Aquarius Data Processing System (ADPS). In addition, the joint effort with NASA and CONAE involves some unique strategies for scheduling and acquiring the instrument data downlinks. The following subsections describe the data acquisition and data processing scenarios for Aquarius.

Data Acquisition

The Aquarius data are downlinked from the SAC-D satellite to the CONAE ground station in Cordoba, Argentina at every opportunity. A station in Matera, Italy also acquired downlinks daily during the early mission, and regularly since then as scheduled by CONAE. SAC-D is in a terminator orbit, so the downlinks are near 6 AM and 6 PM local time. There are two or three overpasses of sufficient duration each morning and evening. During each downlink the Aquarius data are transmitted in parallel with SAC-D spacecraft telemetry and other instrument data.

Aquarius records data in onboard memory. The memory allocation is equivalent to 18 hours of science data. The total memory contents require about 4 minutes to downlink. Since most passes are longer than this, the strategy is to downlink the data repeatedly during the contact. Thus, some data may be downlinked up to three times during a single pass. Also, for downlinks on consecutive orbits, most of the data are duplicated among the passes.

Each Aquarius high-rage-data (HRD) downlink file is processed to remove transmission protocol and stored on the Customer User Support System (CUSS) FTP site at CONAE. Additional files containing spacecraft ephemeris and housekeeping telemetry (HKT) are also provided by CONAE on the FTP site. The details of the interface between CONAE and the ADPS are described in reference 1. The HRD and HKT files are staged and acquired after each downlink, while the ephemeris files are acquired daily.

Data Processing

The processing flow for the Aquarius data is shown in Figure 3.2.5-1. The processing steps and product levels follow the EOS standard data product levels described in Section 4. The Aquarius science data processing consists of the following steps:

- Level-0 Preprocessor – process each HRD downlink file to produce a single time-ordered set of Aquarius science blocks.
- Level-0-to-1A – separate Level-0 files into orbits, unpack science data, incorporate overlapping ephemeris and SAC-D HKT and convert Aquarius HKT.

- Telemetry Analysis – HKT data from Level-1A files are analyzed for web display on the Aquarius web site.
- Level-1A Merge – consolidate Level-1A files from overlapping downlinks into a single, best-quality full orbit product.
- Level-1A-to-2 – perform calibration, atmospheric correction and salinity retrieval for Aquarius science data; this includes Level-1B processing.
- Level-2-to-3 Binning – Level-2 salinity retrievals for one day are geographically projected and collected into equal-area bins.
- Level-2-to-3 Smoothing – Level-2 salinity retrievals for one day are optimally interpolated into equal-area bins.
- Level-3 Binning – Level-3 binned files are aggregated to longer time periods (weekly, monthly, etc.).
- Level-3 Mapping – Level-3 binned files are reprojected onto a 1-degree equal-angle grid to generate global map products.

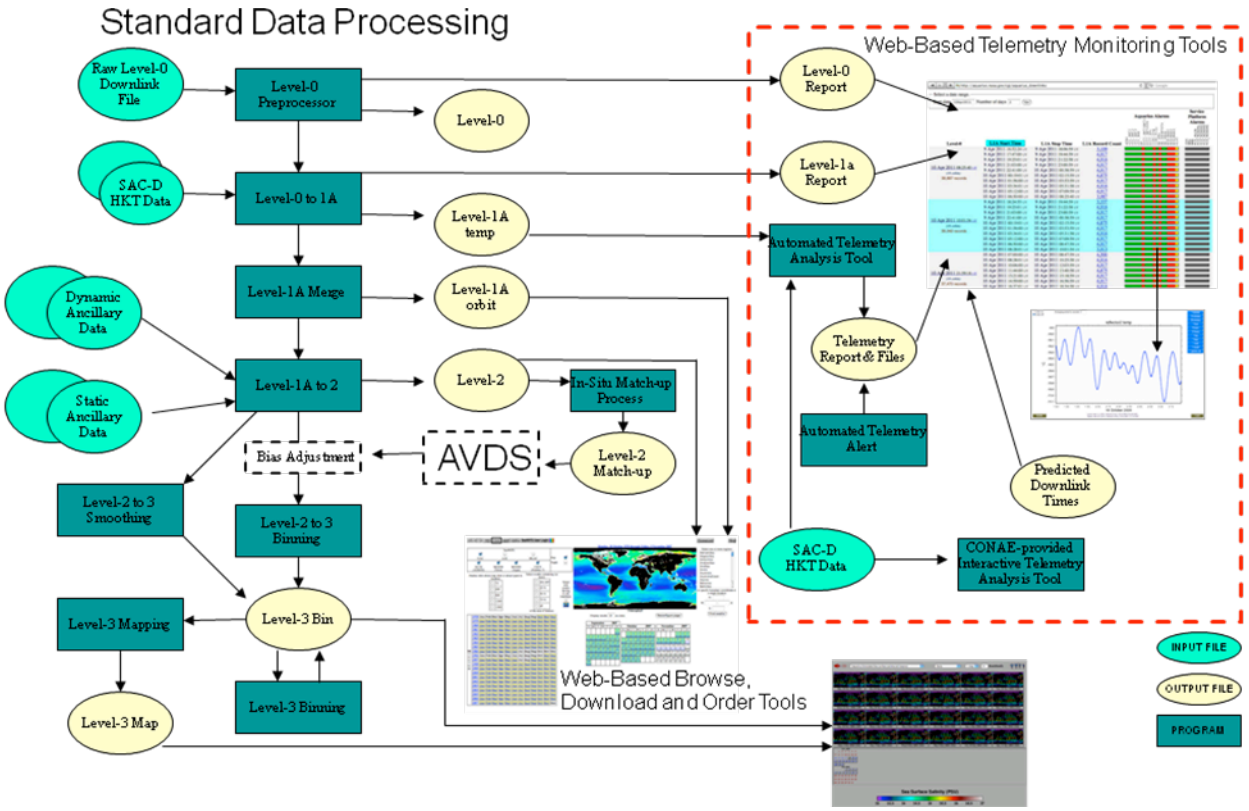


Figure 3-1. Aquarius Data Processing Flow

The Level-0 and 1A processing algorithms and software are developed entirely by the OBPG. The Level-1B and 2 algorithms and science code are developed by the Aquarius Science Team. The radiometer code is developed by Remote Sensing Systems (RSS) in Santa Rosa, CA, and the scatterometer the code is delivered to the OBPG, who are responsible for the implementation of the operational software, including data product input/output and quality flags. The Level-3

binning software is adapted from the existing Ocean product software. The Level-3 smoothing algorithms were provided by the Science Team and implemented in software by the OBPG.

The ancillary data requirements for Aquarius are also unique. The requirements for the Aquarius ancillary data types and sources are given in Reference 2. This information is summarized in Table 3-2.

Data Distribution

The products are distributed to the Aquarius Science Team through the ODPS web-based browse and distribution system. The products are also delivered to the Physical Oceanography DAAC (PO.DAAC) at JPL, as described in Reference 3. In accordance with the Aquarius Level-3 Requirements, the initial product delivery will be made no later than 12 months after launch, and all subsequent deliveries within 6 months of data acquisition. The method of delivery will be for the PO.DAAC to acquire the products from the ODPS distribution site.

Table 3-2. Aquarius Ancillary Data Types and Sources

Data Type	**Static/ Dynamic**	**Primary Source**	**Backup Source(s)**
Pressure, Temperature, Water Vapor Profiles	D	NCEP	
Sea Surface Temperature	D	Reynolds	MISST/GHRSST
Sea Surface Wind Speed	D	NCEP	SAC-D MWR DMSP
Significant Wave Height	D	NCEP	
Total Atmospheric Liquid Water	D	NCEP	SAC-D MWR GPM
Sea Ice Concentration/Extent/Age	D	NCEP	NSIDC
Solar Flux and Flares at 1.4 GHz	D	USAF (NGDC)	
Sea Surface Salinity	D	HYCOM	
Land Mask	S	RSS	
Galactic Background at 1.4 GHz	S	RSS	

3.2.7 VIIRS

The VIIRS support within ODPS is unique, in that NASA has no official responsibility for data product generation, archiving or distribution for NPP. The official data products will be generated at the NOAA National Environmental Satellite Data and Information System (NESDIS) by the JPSS Interface Data Processing Segment (IDPS), and archiving and distribution will be performed by the NOAA Comprehensive Large Array Stewardship System (CLASS) Archive Data Segment (ADS). The responsibilities of the NASA Science teams are to evaluate the NPP data products for continuity with products produced by predecessor missions and sensors, and recommend improvements to the processing algorithms.

NASA developed the NPP Science Data Segment (SDS) to support the activities of the NASA science discipline teams. The SDS consists of the central Science Data Depository and Distribution Element (SD3E), and multiple, discipline-specific Product Evaluation and Analysis Tools Elements (PEATEs). The ODPS has been designated as the Ocean PEATE. It supports the NASA VIIRS Ocean Science Team (VOST) in the evaluation of the VIIRS Ocean Products, which are Ocean Color and Chlorophyll (OCC) and SST. The ODPS processes the VIIRS data using the OBPG algorithms and software, for comparison with the official NPP data products. The following subsections describe the Data Acquisition and Data Processing for VIIRS.

Data Acquisition

The primary data interface between NASA and NOAA is the SD3E, which acquires NPP data products from both the IDPS and CLASS. The products to be acquired are specified by subscriptions that are entered by the SD3E, according to product requests provided by the PEATEs. The IDPS-to-SDS interface is specified in Reference 5.

The NPP data products are specified as Raw Data Records (RDRs, Level-0 equivalent), Sensor Data Records (SDRs, Level-1B equivalents), Environmental Data Records (EDRs, Level-2 equivalents) and Intermediate Products (IPs). More details of the VIIRS data products are provided in Section 4.

The VIIRS products of interest for the Ocean PEATE are the RDRs, 750 m resolution (M-band) SDRs (used for ocean product generation) and the OCC and SST EDRs. The ODPS acquires these products from the SD3E using the active scan method described in Section 3.1.1. The RDRs are permanently archived at the ODPS.

The CLASS/ADS is the permanent archive and distribution site for all NPP and JPSS data products to the general user community. For NASA, this is the source of all NPP products in addition to those received from the IDPS, including SDRs and EDRs, and any products that need to be replaced due to data loss. The PEATEs can request and acquire NPP data products directly from the CLASS/ADS, using the general-purpose user interface.

Data Processing

The Ocean PEATE has no official responsibility for VIIRS data processing. As stated above, NASA's science role for NPP is evaluating EDRs and recommending algorithm and software improvements.

The IDPS operational processing software is designed to run under control of the IDPS infrastructure, and to read and write data from internal stores. A standalone version of the software, known as the Algorithm Development Laboratory (ADL), has been developed by NOAA and distributed by the University of Wisconsin. The ODPS has installed the VIIRS SDR processing module from ADL, in order to support processing and reprocessing of VIIRS RDRs to SDRs with calibration tables generated by the VOST.

The ADL SDR software as currently implemented can only use static look-up tables (LUTs) for the instrument parameters, including the radiometric gains. To support a time-dependent VIIRS calibration, the ODPS has implemented the capability to read a file of time-dependent gains and generate LUTs on-the-fly to process each VIIRS granule.

The remaining processing is performed using modified versions of the standard OBPG software. The VIIRS SDRs are input to l2gen and used to generate Level-2 products with the same content and format as the other instrument ocean color products.

In order to support time-series analyses and comparisons with other sensors, the ODPS also provides the capability to process the OCC and SST EDRs to Level-3. This processing uses the multi-mission l2bin software, modified to accept EDRs as input.

Data Distribution

As stated above, the official distribution of all NPP products is performed by the NOAA CLASS. All ODPS-acquired and generated data products for VIIRS will be cataloged and available within the OBPG and to science team members for evaluation and validation. The ODPS-generated products are available on the browse and order site, while the acquired IDPS products are archived for internal use.

4.0 DATA PRODUCTS

The following section summarizes the data product levels as defined by EOS, and then present the specific products generated for each sensor.

4.1 Data Product Definitions

The OBPG data products generally follow EOS standard data product levels (Reference 4), as follows:

- Level-0 data products are reconstructed, unprocessed instrument/payload data at full resolution; any and all communications artifacts, e.g. synchronization frames, communications headers, duplicate data removed.

- Level-1A data products are reconstructed, unprocessed instrument data at full resolution, time-referenced, and annotated with ancillary information, including radiometric and geometric calibration coefficients and georeferencing parameters, e.g., platform ephemeris, computed and appended but not applied to the Level-0 data.

- Level-1B data products are Level-1A data that have been processed to sensor units (not all instruments will have a Level 1B equivalent).

- Level-2 data products are derived geophysical variables at the same resolution and location as the Level-1 source data.

- Level-3 data products are variables mapped on uniform space-time grid scales, usually with some completeness and consistency.

4.2 Data Products by Sensor

The defining data product characteristics for each sensor are the temporal coverage, either the granule periods (Level-1 and 2) or compositing periods (Level-3). This information is summarized in Table 15.

The Ocean Color products all include combinations of the following derived geophysical parameters: normalized water-leaving radiance (nLw) or remote sensing reflectance (Rrs) at multiple visible wavelengths; chlorophyll-A concentration (chl-a); aerosol optical thickness (AOT), τ, in one red or NIR band; angstrom coefficient, Å; the diffuse attenuation coefficient at 490 nm, K490; calcite concentration or particulate inorganic carbon (PIC); particulate organic carbon (POC); chromophoric dissolved organic matter (CDOM) index; photosynthetically available radiation (PAR); and fluorescence line height (FLH). The MODIS SST products include 4-micron (nighttime only) and 11-micron (daytime and nighttime) SST. For the Level-3 products, each binned product contains multiple geophysical parameters, while the SMI products contain one parameter per granule.

All products include metadata that contain information about the mission, sensor and granule. In addition, each product level contains additional specific data fields. Level-1 products contain sensor and satellite telemetry in raw or converted form. Level-2 products include flags and masks for each pixel that indicate algorithm success and data quality. Level-3 binned products contain statistical information about the samples in each bin.

The following subsections describe the specific products for each sensor, including any unique products. The detailed product format descriptions are provided in the format specifications listed as references 6 and 7.

Table 4-1 – Data Product Temporal Characteristics

Sensor	**Level-1 and 2 Granule Period(s)**	**Level-3 Compositing Periods**
CZCS	Variable, up to (original products) Variable, up to 40 minutes (MLAC)	Daily, 8 days, Monthly, Seasonal, Annual, Mission
OCTS	50 minutes (daylit orbit)	Daily, 8 days, Monthly, Seasonal, Annual, Mission
SeaWiFS	40 to 43.66 minutes[1] (GAC) Variable, 30 – 120 seconds (LAC) Variable, up to 15 minutes (HRPT) Variable, up to 43.66 minutes (MLAC)	Daily, 8 days, Monthly, Seasonal, Annual, Mission
MODIS	5 minutes	Daily, 8 days, Monthly, Seasonal, Annual, Mission
MERIS	Variable, up to 43 minutes (RR) Variable, up to 15 minutes (FRS)	Daily, 8 days, Monthly, Seasonal, Annual, Mission
Aquarius	1 orbit (98 minutes; Level-1A includes 10 minutes overlap with adjacent orbits)	Daily, Weekly, Monthly
VIIRS	85.5 seconds	Daily, 8 days, Monthly, Seasonal, Annual, Mission[2]

[1] The SeaWiFS GAC recording period was extended on September 23, 2000 from 40 minutes to 43 minutes 40 seconds. It was changed back to 40 minutes on November 9, 2010.
[2] There are no official JPSS VIIRS Level-3 Ocean products. The ODPS will generate Level-3 products from VIIRS EDRs for evaluation purposes.

4.2.1 CZCS

The CZCS distributed data products include the Level 1A MLAC, Level 2 MLAC, Level-3 binned and Level-3 standard mapped images (SMI)

Table 4-2 – CZCS Data Products

Product	Fields	Resolution
Level-1A MLAC	Raw instrument data numbers (DN) for all 6 CZCS bands	800 m
Level-2 MLAC	Rrs (at 443, 520, 550 and 670 nm), chl-a, τ670, and K490	800 m
Level-3 Binned	Rrs, chl-a, τ670, and K490	9 km
Level-3 SMI	Rrs, chl-a, τ670, and K490	9 km

4.2.2 OCTS

The OCTS distributed data products include the Level 1A GAC, Level 2 GAC, Level-3 binned and Level-3 SMI.

Table 4-3 – OCTS Data Products

Product	Fields	Resolution
Level-1A GAC	Raw instrument data numbers (DN) for all 12 OCTS bands	3.5 km
Level-2 GAC	Rrs (at 412, 443, 490, 516, 565 and 667 nm), chl-a, τ862, Å443, K490, and PIC	3.5 km
Level-3 Binned	Rrs, chl-a, τ862, Å443, K490, and PIC	9 km
Level-3 SMI	Rrs, chl-a, τ862, Å520, K490, and PIC	9 km

4.2.3 SeaWiFS

The SeaWiFS distributed data products include the Level 1A GAC and MLAC, Level 2 GAC and MLAC, Level-3 binned and Level-3 SMI. The Level-3 products also include photosynthetically available radiation (PAR), land surface reflectance (LSR) and normalized difference vegetation index (NDVI).

Table 4-4 – SeaWiFS Data Products

Product	Fields	Resolution
Level-1A GAC Level-1A MLAC	Raw instrument data numbers (DN) for all 8 SeaWiFS bands	4.4 Km 1.1 km
Level-2 GAC Level-2 MLAC	Rrs (412, 443, 490, 510, 555 and 670 nm), chl-a, τ865, Å443, K490, PIC, POC, CDOM and PAR.	4.4 km 1.1 km
Level-3 Binned Ocean Color	Rrs, chl-a, τ865, Å510, K490, PIC, POC, CDOM and PAR	9 km
Level-3 Binned Special Products	LSR	9 km
Level-3 SMI	Rrs, chl-a, τ865, Å510, K490, PIC, POC, CDOM, PAR, and NDVI	9 km

4.2.4 MODIS

The MODIS distributed data products include Level-1A, Level-2 Ocean Color and SST, Level-3 binned Ocean color and SST, and Level-3 SMI.

Table 4-5 – MODIS Data Products

Product	Fields	Resolution
Level-1A	Raw instrument data numbers (DN) for all 36 MODIS bands	1 km
Level-2 Ocean Color	Rrs (at 412, 443, 469, 488, 531, 547, 555, 645, 667 and 678 nm), chl-a, τ869, Å443, K490, PIC, POC, CDOM index, PAR, IPAR, and NFLH	1 km
Level-2 SST	11 micron (day/night) and 4 micron (night only) SST	1 km
Level-3 Binned Ocean Color	Rrs, chl-a, τ869, Å443, K490, PIC, POC, CDOM index, PAR, IPAR, and NFLH	4 km
Level-3 Binned SST	11 micron day, 11 micron night and 4 micron	4 km
Level-3 SMI	Rrs, chl-a, τ869, Å443, K490, PIC, POC, CDOM index, PAR, IPAR, NFLH, 11 micron day SST, 11 micron night SST and 4 micron SST	4 and 9 km

4.2.5 MERIS

The MERIS distributed data products include Level-1B and Level-2.

Table 4-5 – MERIS Data Products

Product	Fields	Resolution
Level-1B	Calibrated TOA radiances for MERIS bands	300 m
Level-2	Rrs (at 413, 443, 490, 510, 560, 620, 665 and 681 nm), chl-a, τ865, Å443 and K490	300 m
Level-3 Binned	Rrs, chl-a, τ869, Å443, K490	4 km
Level-3 SMI	Rrs, chl-a, τ869, Å443, K490	4 and 9 km

4.2.6 Aquarius

The Aquarius data products include Level 1A, Level-2, and Level 3 binned and mapped salinity products.

Table 4-6 – Aquarius Data Products

Product	Fields	Resolution
Level-1A	Raw radiometer and scatterometer data numbers (DN) for each horn and polarization	~100 km
Level-2	Radiometer brightness temperatures and scatterometer signal return strength for each beam and polarization; surface brightness temperatures and SSS for each beam; ancillary data fields interpolated to beam times and locations.	~100 km
Level-3 Binned	Binned or optimally smoothed SSS on latitude-longitude grid	1 degree
Level-3 SMI	Map-projected Level-3 SSS	1 degree

4.2.7 VIIRS

The official VIIRS data products are defined by the JPSS requirements specification, with formats specified in Reference 6. As described in Section 3.2.6, the JPSS products are analogous to the EOS product levels. The ODPS is not responsible for distributing VIIRS products to the general user community, although they are available through the web-based interface.

Table 4-7 – VIIRS Data Products

Product	Fields	Resolution
RDR (Level-0)	Raw instrument data numbers (DN) for 22 VIIRS bands	750 m and 375 m
SDR (Level-1B)	Calibrated top-of-atmosphere radiance and reflectance for all 22 VIIRS bands	750 m and 375 m
Level-2	Rrs (at 410, 443, 486, 551, and 671 nm), chl-a, τ862, Å443, and K490	750 m
OCC EDR	nLw and inherent optical properties (IOPs, i.e., absorption and backscattering coefficients) (at 410, 443, 486, 551 and 671 nm), and chl-a	750 m
SST EDR	SST (11-micron)	750 m
Level-3 Binned Ocean Color	Rrs, chl-a, τ869, Å443, and K490	4 km
Level-3 Binned OCC EDR	nLw and chl-a	4 km
Level-3 SMI	Rrs, chl-a, τ862, Å443, and K490	4 and 9 km
Level-3 EDR SMI	nLw and chl-a	4 and 9 km

5.0 DATA RIGHTS AND RULES FOR DATA USE

The ODPS policy is to publicly release all versions of all data products as soon as they are processed, except for sensors which have specific restrictions (e.g. commercial data rights). Products that are still undergoing validation are indicated as provisional. Exceptions to this policy were noted for each sensor in Section 3.2.

6.0 REFERENCES

1. SACD Ground Segment to Aquarius Ground Segment ICD, AS-336-0151b, April 2011.

2. Aquarius L3 Science Algorithm Requirements, D-29053, May 2011.

3. Aquarius Ground Segment to PO.DAAC ICD, AQ-336-0151d, May 2011.

4. EOS Data Products Handbook, ed. M.D. King, et al, NASA/GSFC, 2003.

5. JPSS to NPP SDS Interface Control Document (ICD), 474-00016, June 2012.

6. JPSS Common Data Format Control Book (CDFCB) – External, Volumes I – VII, 474-00001

7. OBPG data product format specifications are maintained online at: http://oceancolor.gsfc.nasa.gov/DOCS/ocformats.html

8. Aquarius data product format specifications are maintained online at: http://oceancolor.gsfc.nasa.gov/WIKI/AQ%282f%29GS.html

APPENDIX A- ACRONYM LIST

ADEOS	Advanced Earth Observing Satellite
ADM	Archive Device Manager
ADS	Archive Data Segment
CAN	Cooperative Agreement Notice
CCD	Charge-coupled device
CDOM	Chromophoric dissolved organic matter
CLASS	Comprehensive Large Array Stewardship Segment
CONAE	Comision Nacional de Actividades Espaciales
CZCS	Coastal Zone Color Scanner
DAAC	Distributed Active Archive Center
DoD	Department of Defense
EDR	Environmental Data Record
EOS	Earth Observing System
ESA	European Space Agency
FLH	Fluorescence line height
GAC	Global Area Coverage
GESDAAC	Goddard Earth Sciences DAAC
GSFC	Goddard Space Flight Center
HDF	Hierarchical Data Format
HKT	Housekeeping telemetry
HRPT	High-resolution Picture Transmission
I&TSE	Integration and Test Support Element
IDPS	Interface Data Processing Segment
IPO	Integrated Program Office
JPL	Jet Propulsion Laboratory
JPSS	Joint Polar Satellite System
LAC	Local Area Coverage
MODAPS	MODIS Adaptive Processing System
MERIS	Medium Resolution Imaging Spectrometer
MLAC	Merged LAC
MODIS	Moderate-resolution Imaging Spectroradiometer
NDVI	Normalized difference vegetation index
nLw	Normalized water-leaving radiance
NOAA	National Oceanic and Atmospheric Administration
NPP	National Polar-orbiting Partnership
OBPG	Ocean Biology Processing Group
OCTS	Ocean Color and Temperature Scanner
ODPS	Ocean Data Processing System
OEL	Ocean Ecology Laboratory
OSC	Orbital Sciences Corporation
PAR	Photosynthetically available radiation
PEATE	Product Evaluation and Analysis Tools Element
PIC	Particulate inorganic carbon
POC	Particulate organic carbon

PO.DAAC	Physical Oceanography DAAC
RDR	Raw Data Record
REASoN	Research, Education and Applications Solutions Network
Rrs	Remote sensing reflectance
RSS	Remote Sensing Systems
SAC-D	Satelite de Aplicaciones Científicas D
SD3E	Science Data Depository and Distribution Element
SDR	Sensor Data Record
SDS	Science Data Segment
SeaWiFS	Sea-viewing Wide Field-of-view Sensor
SSS	Sea surface salinity
SST	Sea surface temperature
TDI	Time delay integration
VDC	Visual Database Cookbook
VIIRS	Visible and Infrared Imager/Radiometer Suite